Exemption No. 6435

UNITED STATES OF AMERICA
DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION
RENTON, WASHINGTON 98055-4056

In the matter of the petition of Cessna Aircraft Company for an exemption from § 25.1305(d)(3) of the Federal Aviation Regulations	Regulatory Docket No. 28372

DENIAL OF EXEMPTION

By petition dated October 4, 1995, Mr. Donald W. Mallonee, Executive Engineer, Cessna Aircraft Company, One Cessna Blvd., P.O. Box 7704, Wichita, Kansas 67277-7704, petitioned for exemption from the rotor system imbalance indicator requirements of § 25.1305(d)(3) for the Cessna Model 550 Citation II airplane at Production Serial 550-0801.

Sections of the FAR affected:

Section 25.1305(d)(3) requires an indicator to indicate engine rotor system unbalance on turbojet powered airplanes.

The petitioner's supportive information is as follows:

"BACKGROUND

"Cessna has determined to incorporate a group of product improvements in the Cessna Model 550 Citation II airplane at Production Serial 550-0801. Included in these product improvements is a change in engines from Pratt and Whitney Canada JT15D-4 engines to Pratt and Whitney PW530A engines. An FAA certification project for this group of changes has been designated as AT0706WI-T. Completion of this project is anticipated for mid-summer 1996.

"The Cessna Model 550 airplane is presently approved as Item II under Type Certificate No. A22CE. The certification basis as shown in TCDS A22CE for Model 550 is:

> "Part 25 of the Federal Aviation Regulations effective February 1, 1965, as amended by 25-1 thru 25-17; except Paragraphs 25.934 and 25.1091(d)(2) as amended thru 25-23; 25.1401 as amended through 25-27:, 25.1387 as amended through 25-30; 25.1303(a)(2) and 25.1385(c) as amended through 25-38; plus (Special Conditions 25-25-CE-4, FAR 36, and SFAR 27).

"Application of present FAA policies, as reflected in various documents, including FAA Order 8110-4A, has led to application of currently amended FAR 25 in areas for which Cessna has proposed changes to be incorporated at Serial 550-0801. Among the amended regulations considered to be related to the change of engines is § 25.1305, Powerplant instruments, that was recently amended at 25-72. It is observed that § 25.1305 has also been amended by 25-36, 25-38, and 25-54 as well as 25.72, none of which affect § 25.1305(d)(3).

"At Amendment 25-35, § 25.1305(d) was amended by the addition of subparagraph (d)(3) which calls for, 'An indicator to indicate rotor system unbalance.' It is noted that the certification basis of Model 550 has not included this provision, nor has any other model (500, 550, S550, 552, or 560) type certificated under A22CE, and that all except the original Model 500 has been developed subsequent to the promulgation of Amendment 25-36.

"It is further noted that FAA Exemption No. 3436 has been granted to address the same issue for Cessna Model 650, Type Certificate No. A9NM.

"OPERATING HISTORY OF CITATION FLEET

"Various models of the Cessna Citation fleet have been operating in all kinds of environmental conditions around the world since the initial Type Certificate was issued in September of 1971. This fleet of over 2,000 airplanes has accumulated in excess of 16-million engine operating hours without experiencing any catastrophic engine failures of the kind assumed by FAA in their Preamble to Amendment 25-35.

"Equally relevant is that none of the airplanes in the Citation fleet were fitted with a rotor system unbalance indicator as contemplated by § 25.1305(d)(3). While the experience cited above may be relatively small compared to the in-service hours of airline equipment, it must be recalled that the cited operating experience represents, in General Aviation usage, a substantial percentage of engine installations that have gone thru their expected number of overhaul/rebuild cycles to eventual retirement. In terms of years, the life

cycles of General Aviation airplanes are approximately the same as airline equipment, but the normal 300 to 500 hour annual utilization rate for General Aviation airplanes results in a much lower number of airframe hours at the time they are withdrawn from service.

"It is not possible to extract from operational records of the Citation fleet the number of occasions where crew identification of engine abnormalities has led to actions that have prevented those abnormalities from progressing to catastrophic events. However, the absence of catastrophic events makes it clear that crews have been successful in perceiving and reacting to whatever abnormalities that have occurred without the need of § 25.1305(d)(3) indicators.

"CONFIGURATION OF P&WC PW530A vs JT15D-4 ENGINES

"Although the PW530A engine is on a different Type Certificate than the JT15D-4, the engine manufacturer has retained a substantial amount of commonality in construction which supports the validity of applying previous service experience to Serial 550-0801. These items of commonality include:

- "* Both engines are approximately equal in physical envelope and are the smallest of any turbofan engines installed in an airplane under FAR 25.
- "* Both are of a two-spool, front fan configuration with a full length bypass duct.
- "* Cores of both engines are comprised of a single stage centrifugal compressor driven by one high pressure turbine.
- "* Both engine fans are driven by two low pressure turbines.
- "* These engines have nearly identical concentric dual-shaft designs with a four bearing support.

"Thus, it is reasonable to expect that the vibration signatures of the two engines to also be similar.

"It should be noted that commonality of engine characteristics between the JT15D and the PW530 is independent of the fact that they are not on the same engine Type Certificate. Please recall that the JT15D-5D , as used on the Model 560 Citation V Ultra (also without a vibration system), is on Type Certificate E45NE while its siblings in the JT15D Family were on Type Certificate E25EA.

"EXPECTED SAFETY BENEFITS OF §25,1305(d)(3)

"In Notice 71-12, FAA said:

> "The rotor system unbalance indicator proposed in new paragraph (d)(3) is necessary since the effect of a rotor system failure can be catastrophic because of the resulting engine unbalance if the flight crew is not provided with an appropriate vibration warning. While present requirements concerning failure of turbine engine installations do not cover the flight crew warning necessary for safety, vibration monitoring systems have been voluntarily installed in most turbine powered transport airplanes currently in operation and Special Conditions have been issued requiring the indicator on Transport Category airplanes using turbojet engines. The FAA is aware that to the extent that currently available vibration detectors are not as reliable as engines, this proposal may impose an economic penalty. Nevertheless, the FAA believes that for airplanes using turbojet engines, a vibration indicator is necessary in the interest of safety (36 FR 8386).

"From the Preamble to Amendment 25-35, the following is quoted:

> "The FAA is aware that currently available vibration detectors are not as reliable as the engines they monitor and to that extent, they may impose an economic penalty; however, a rotor system failure can be catastrophic and the contributions to flight safety gained from a vibration monitoring system that provides the flight-crew with an appropriate vibration warning far outweighs any difficulties that may be experienced. The value of the system has been recognized by the aviation industry in that vibration monitoring systems have been voluntarily installed in most turbine powered Transport Category airplanes currently in production.

"Key safety point assertions drawn from the quoted FAA statements relative to § 25.1305(d)(3) include the following:

- "* Rotor system structural failure can be catastrophic.
- "* Detection of warning levels of vibration is needed by the flightcrew.
- "* Many turbojet transports at the time (circa pre-1970) were operating with voluntarily installed engine vibration indicators.
- "* Type certification programs at the time included the equipment of § 25.1305(d)(3) by special condition.

"* FAA and those who commented appeared to have accepted that the value of engine vibration indicators exceeded the disadvantages of false indication potential.

"Discussion of the key safety assertions as they may relate to this petition is as follows:

"The JT15D series of engines, parents of PW530A have only recorded one incident of rotor fragments penetrating the fan bypass duct. This incident was believed to be the result of an incorrect maintenance procedure and occurred during ground operation, i.e., before flight. Since there has never been an in-flight rotor failure of catastrophic proportions, it cannot be said that sensed vibrations are a viable precursor of rotor failure for JT15D/PW530 engine installations.

"It is agreed that detection of abnormal engine vibration by the flightcrew is important to safe operation. However, we disagreed that installation of instruments registering vibration levels is better than posterior apperception (seat of the pants sensing). Cessna's experience is that vibration abnormalities have been sensed by flightcrews at much lower levels than vibrations that must exceed a nuisance warning level before registering in a cockpit indicator.

"Engine installations referred to in the voluntary installation statements of Notice 71-12 and Amendment 25-35 were predominately those of JT-3 or JT-8 families. The effects of scale differences between those engines and JT-15D engines are that: (1) rotor failures were a frequent occurrence in the larger engine vs a void of failures in the smaller engines, and (2) at the time of the 3-6 June 1969 conference from which Notice 71-12 evolved, there were very few small turbofan engines operating in field service and none at all in the thrust range of 4000 lb or less. In other words, the proposed rule was made without any experience with engines in the size and configuration of the JT15D/ PW530 family. It is our understanding that FAA's experience in dealing with recent catastrophic engine rotor events is all with engines larger than those in service at the time of Notice 71-12, not small turbofans such as JT15D/PW530.

"Special Conditions 25-2-5-CE-4 that were developed for Model 500, and made applicable to other models for Type Certificate A22CE, do not specify a requirement for an indicator to indicate rotor system unbalance. It is noted that any consideration for such a Special Condition for the M5D-1 Model 500 engine installation was rejected since the approval of Special Condition 25-25-CE-4 took place on 10 June 1970 or over a year after the 3-6 June 1969 conference in which FAA had stated a need for such devices.

"As reported in Notice 71-12, FAA's perception of the 3-6 June 1969 conference was that operators of airline equipment held the opinion that the potential value of a vibration monitoring device outweighed- the potential disadvantages of a large percentage of false warnings. In the quarter century since that conference, there have been great strides in technology such that vibration monitoring devices are more reliable. However, their installation still requires them to establish a threshold as a discriminator between significant engine damage and vibrations which present false warnings. It is clear that for engines of the JT15D/PW530 family such a threshold value is well above the vibration level that can be sensed by the crew through structural transmittal. Again, scale is significant. The proximity of the engines to the crew as well as the relatively greater stiffness of the airframe structure between the engines and the crew will assure a stronger vibration signal reaching the cockpit through structure than for the large airplanes being considered at Amendment 25-35.

"PRESENT OPERATING EXPERIENCE

"In 1992 an FAA/Industry project, ANM-92-018-A, developed a white paper which has been provided to this office by the Cessna propulsion specialist who participated. The conclusion of that white paper, a copy of which is attached, is that vibration monitoring is not practical as a means of detecting impending engine failure.

"It should be recalled that Model 550 does not have the kinds of sophisticated electronic diagnostic systems that have been installed in some contemporary transports. Thus, if a vibration indicating device were to be installed, the crew is faced with a question of appropriate indicator interpretation that a large portion of the aviation community has not yet resolved: What action is expected of the crew when indicator thresholds are exceeded? Experience described in the attached paper suggests that vibration indicator installation in Model 550 would not contribute to safety for either of two probable scenarios:

"(a) The crew will have sensed airframe boor vibrations lower than vibration indicator thresholds and made appropriate diagnosis through other indications which would lead to appropriate engine operating decisions, or

"(b) The crew will disregard airframe born vibrations, waiting for annunciation that vibration indicator thresholds have been exceeded. This will increase the probability of experiencing the kind of catastrophic engine damage § 25.1305(d)(3) was intended to prevent.

"In either event, it is clear that the indicator required by § 25.1305(d)(3) provides no safety benefit.

"ECONOMIC FACTORS

"Cost estimates, based on pricing of vendor supplied components, labor and hardware to accomplish installation, and amortization of nonrecurring costs for design and certification of a vibration monitoring system for Model 550, yield a cost to customers of § 25.1305(d)(3) of approximately $30 thousand. It is our understanding that these costs will be applicable to any two-engine airplane, regardless of size.

"Therefore, it is apparent that while for large airline turbojet aircraft the cost of vibration indicating equipment may be an inconsequential fraction of overall maintenance provisions, the costs become a significant economic burden for an aircraft that is at the very bottom of purchase prices for an aircraft manufactured to FAR 25. Cessna's view is that imposition of such an economic burden without a corresponding safety enhancement is, by itself, justification for the requested exemption.

"CONCLUSIONS AND SUMMARY

"The preceding review of the characteristics of 500 Series Citations and the JT15D/PW530 family of engines confirms that the safety intent of § 25.1305(d)(3) is well accomplished without the installation of vibration indicating equipment. Considering that the public interest is served by avoiding the unwarranted economic burden of installing such equipment, the exemption criteria of 14 CFR 11 are met and it is requested that FAA grant the requested exemption."

A summary of Cessna's petition was published in the Federal Register on November 15, 1995 (60 FR 57576). No comments were received.

The FAA's analysis/summary is as follows:

The FAA has carefully considered the information provided by the petitioner, as well as other relevant information, and has determined that there is insufficient merit to warrant granting this petition. The FAA's responses to the above petitioner's supportive information follows:

As correctly stated by Cessna, the original Cessna Model 500 airplane was certified in 1971, long before the § 25.1305(d)(3) rotor unbalance indicator requirement was introduced in Amendment 25-35 (effective March 1, 1974). While some of the follow-on Cessna models (550, S550, 552, or 560) noted in FAA Type Certificate A22CE were certified after § 25.1305(d)(3) became effective, the FAA did not require incorporation of engine unbalance indicators on those airplane models due to the fact that no major engine or cockpit engine indication changes were proposed which would have required a § 25.1305(d)(3) certification basis update. Since the new Cessna Citation II Serial 550-0801 (hereby referred to as the Bravo) incorporates new Pratt & Whitney PW530 engines and falls under the Type

Certification Basis procedures stated in FAA Order 8110.4A (effective March 2, 1995), incorporation of the latest Part 25 requirements for those airplane components and areas affected by the engine change, including Amendment 25-35, is required.

Cessna also correctly states that FAA Exemption No. 3436 was granted for relief from the § 25.1305(d)(3) rotor unbalance indicator requirements for the Cessna Model 650 aircraft (different FAA Type Certificate than the Model 550). Actually, several "business jet" models were granted exemptions from the provisions of § 25.1305(d)(3) during the early 1980's. These exemptions were based on the premise that inadequate rotor unbalance indicator reliability would cause an excessive number of nuisance indications, and that engine rotor unbalance can be felt in the cockpit for airplanes with fuselage mounted engines. However, since 1983 it has been the FAA's position that reliable rotor unbalance indicator systems are available from most vendors, and when properly integrated into the airframe, offer an increased level of safety with minimal nuisance indications. Thus, no additional § 25.1305(d)(3) exemptions have been granted since 1984.

The FAA recognizes that on most engines, detection of impending engine failure (as cited in preamble to Amendment 25-35) by a vibration indicator may not always be practical or timely. However, based on the two decades of in service operating experience on both small and large part 25 airplanes, rotor unbalance indictors have provided a safety benefit in the form of providing crew information for the following scenarios:

(1) On all aircraft, the rotor unbalance indicators provide immediate crew assistance in identifying the affected engine following a foreign object damage (FOD) or other potential engine damage event.

(2) On a few aircraft, the primary use of the rotor unbalance indicator is to provide crew information which enables the crew to carry out procedures which insure part 33- established engine vibration limits are not exceeded.

The FAA considers the safety benefit noted in item 1 above to be especially critical on airplanes like the Cessna Bravo which have aft-fuselage mounted engines. Timely crew identification of which engine has had an FOD or other engine damage event based solely on what Cessna refers to as "posterior apperception," can be particularly difficult when both engine mounts are closely coupled together on the aft end of the airplane's fuselage. It should be noted that incorrect crew identification of a damaged engine has been cited as a contributing factor in at least one recent part 25 airplane accident. Independent of whether the engines are mounted on the aft fuselage or the wing, rotor unbalance indicators provide the crew with an immediate confirmation of which engine may have experienced some level of damage.

Lastly, the FAA does not concur with Cessna's view that the rotor unbalance indicator represents an economic burden without a corresponding safety enhancement. The safety

benefit of a rotor unbalance indicator is clearly defined by the FAA in the preceding paragraphs as well as in the 1992 FAA/Aerospace Industries Association (AIA) AVM white paper document which was referenced and attached to Cessna's exemption request. Furthermore, rotor unbalance indicators have been FAA type certificated over the last 22 years without undue economic burden on many airplanes which are similar to the Bravo in both physical size and price.

In consideration of the foregoing, I find that a grant of exemption is not in the public interest. Therefore, pursuant to the authority contained in §§ 313(a) and 601(c) of the Federal Aviation Act of 1958, delegated to me by the Administrator (14 CFR 11.53), the petition of Cessna Aircraft Company for an exemption from the engine rotor system unbalance indicator requirements of § 25.1305(d)(3) of the FAR, on the Cessna Citation II Serial 550-0801 (Citation Bravo) airplane, is hereby denied.

Issued in Renton, Washington, on May 8, 1996

/s/
Stewart R. Miller
Acting Manager,
Transport Airplane Directorate
Aircraft Certification Service, ANM-100